A Sampling of Climate Research in Oregon

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Outline for Talk

- Learning from ancient climates
- Learning from global processes
- From physical climate to carbon to ecosystems to policy
- From processes to linkages to responses

Climate Change Impacts Depend on Variability

- Variability may have more human impact than mean state.
- Examples:
  - European heat wave
  - Niger drought

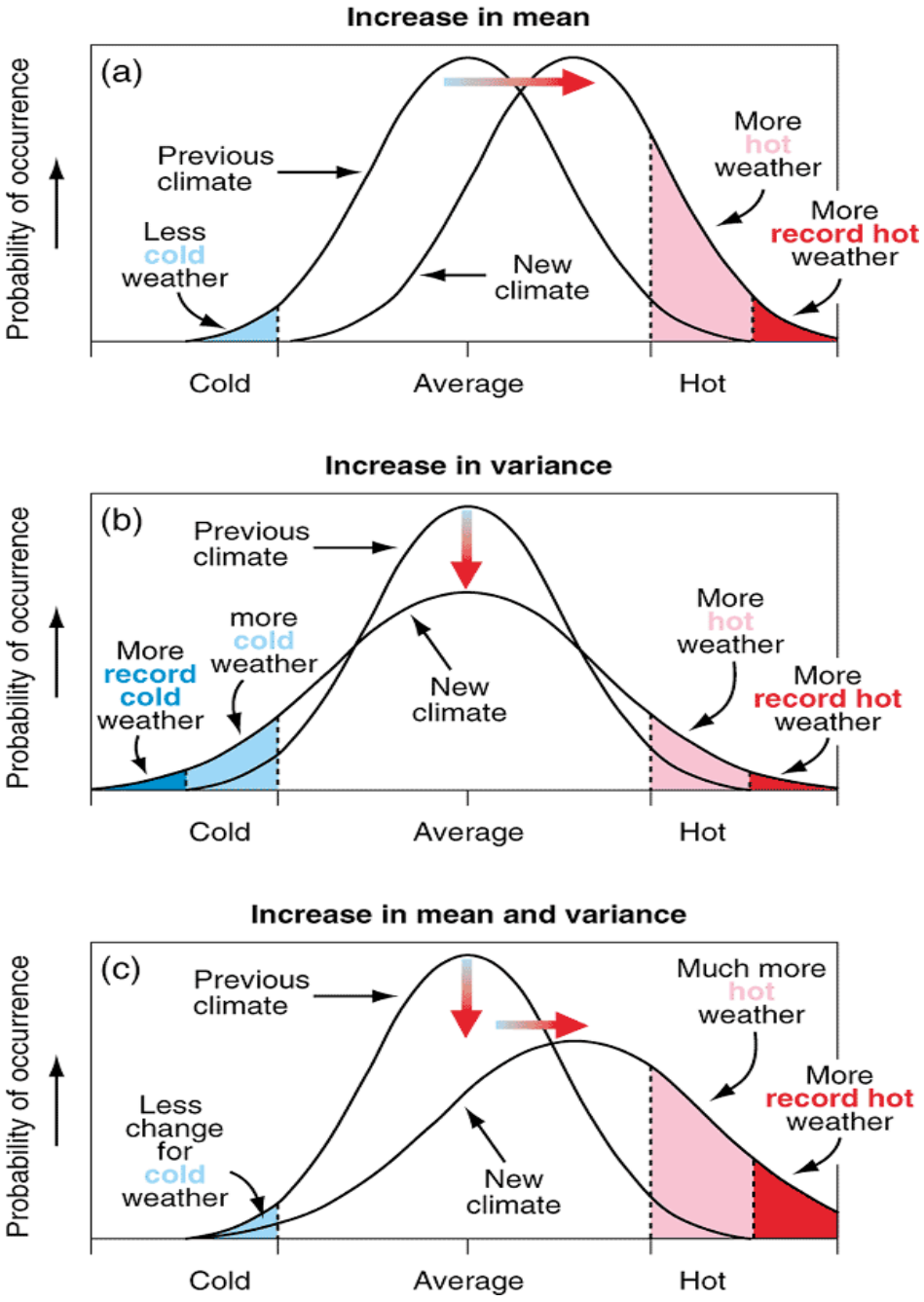
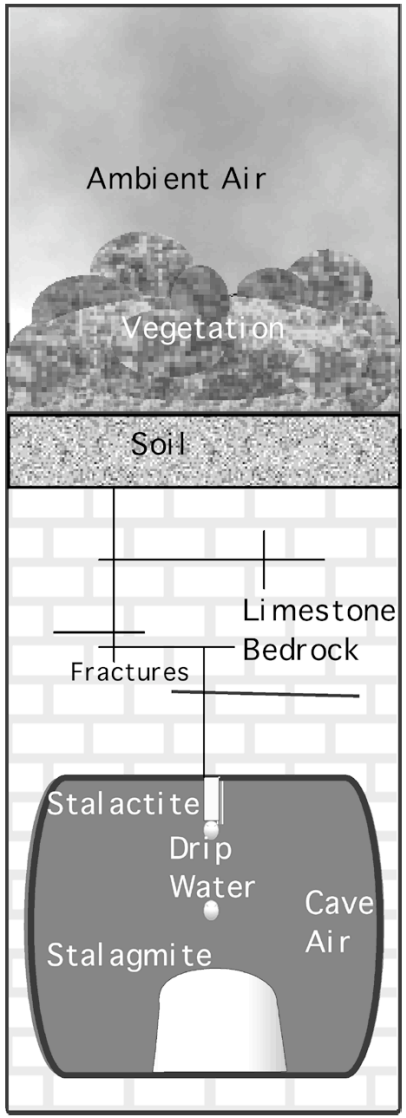
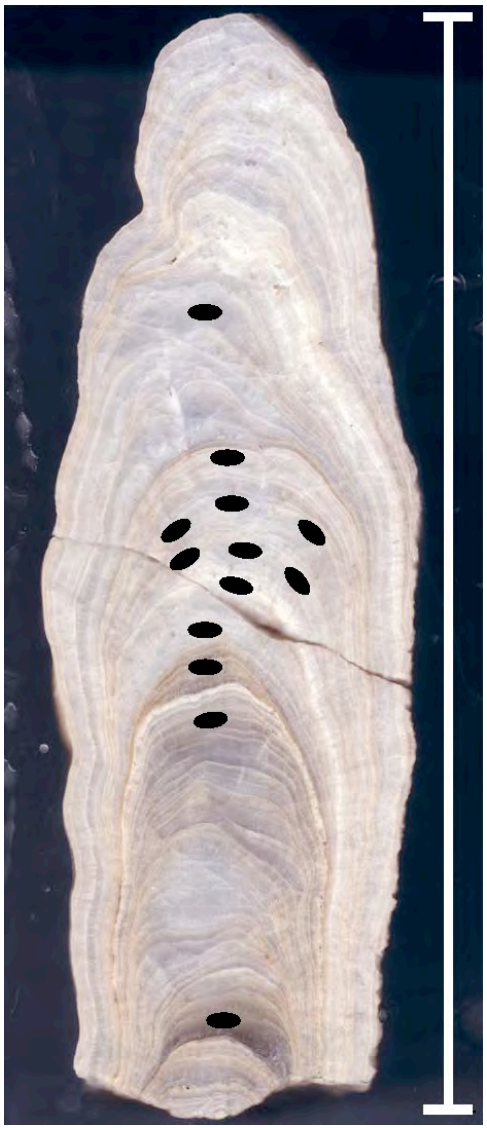


Figure courtesy A. Mix, OSU

Stalagmites from Oregon Caves Nat. Mon.





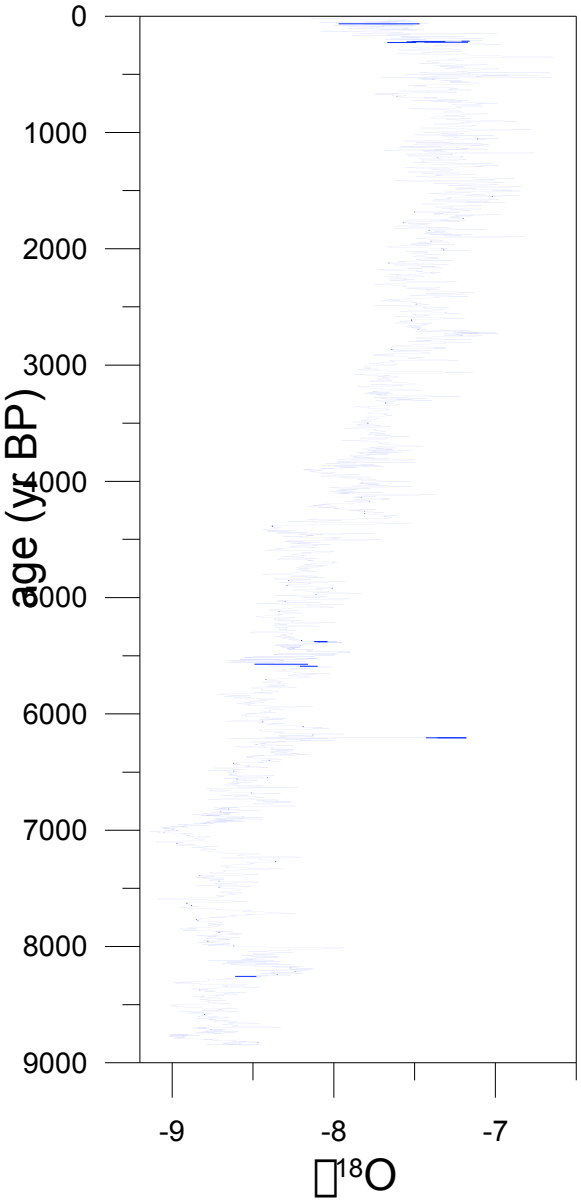


Figure courtesy A. Mix, OSU

Collapse of the North Atlantic Ecosystem

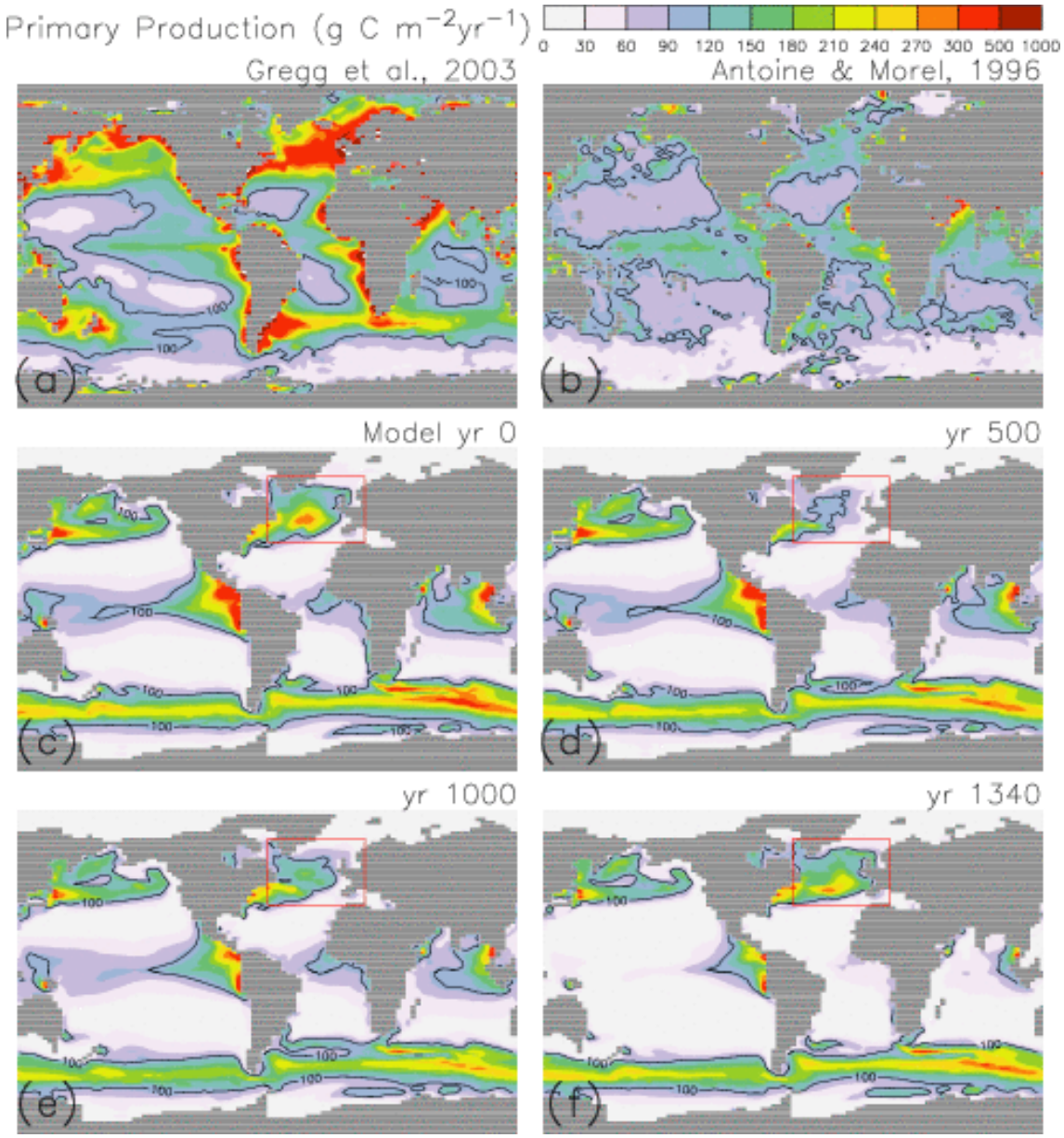


Figure courtesy A. Schmittner, OSU

Teleconnections with Tibet

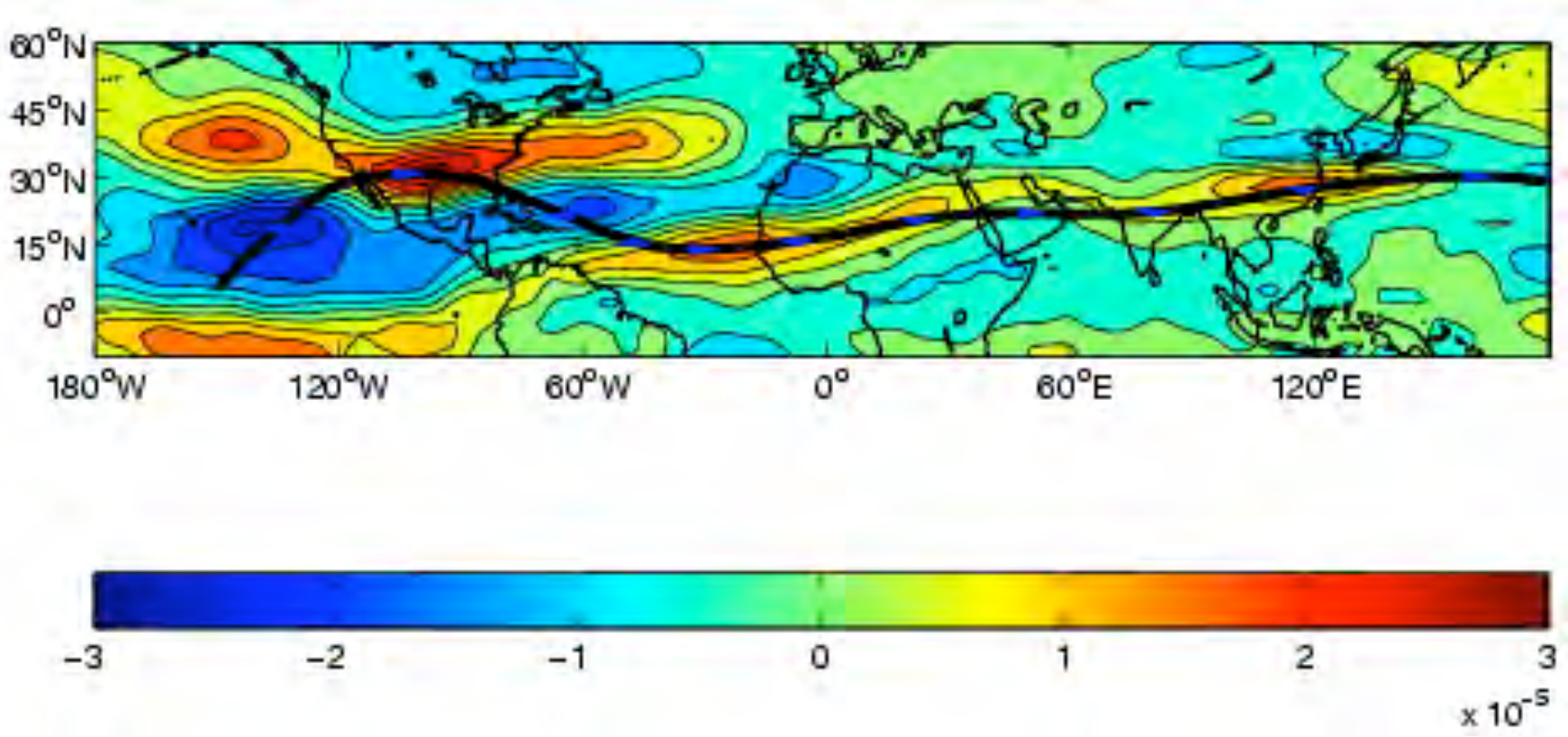
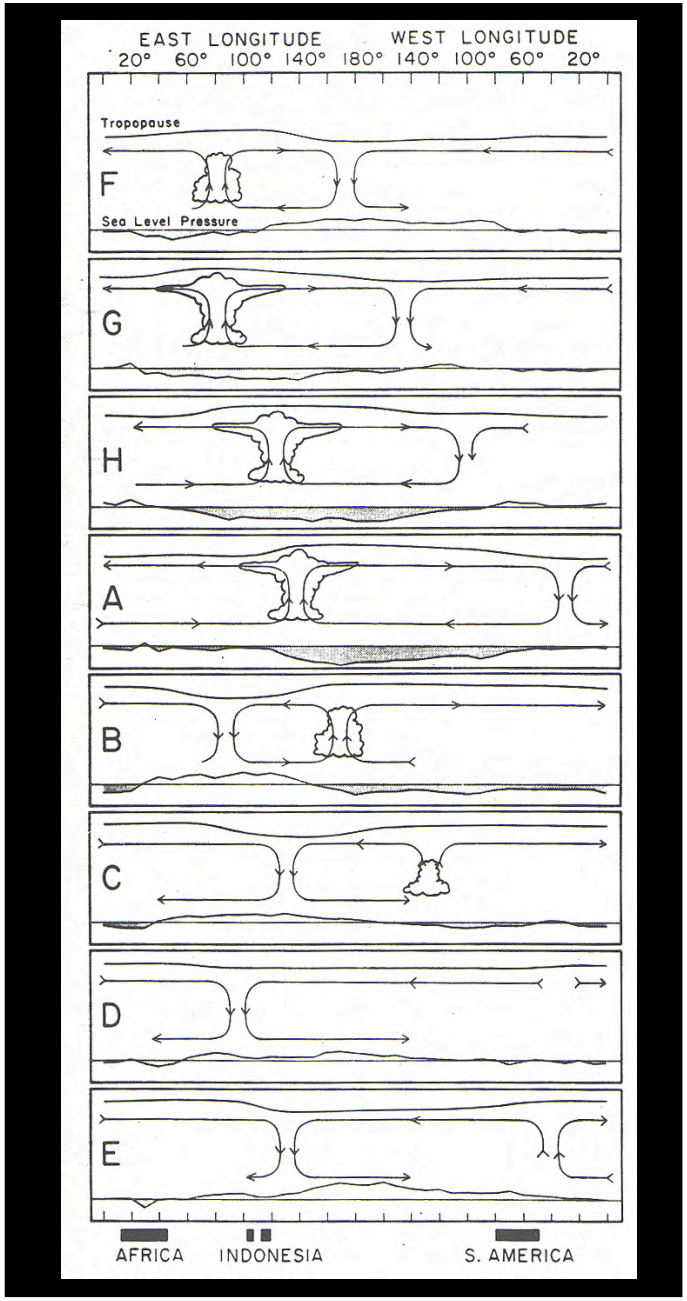


Figure courtesy J. Shaman, OSU

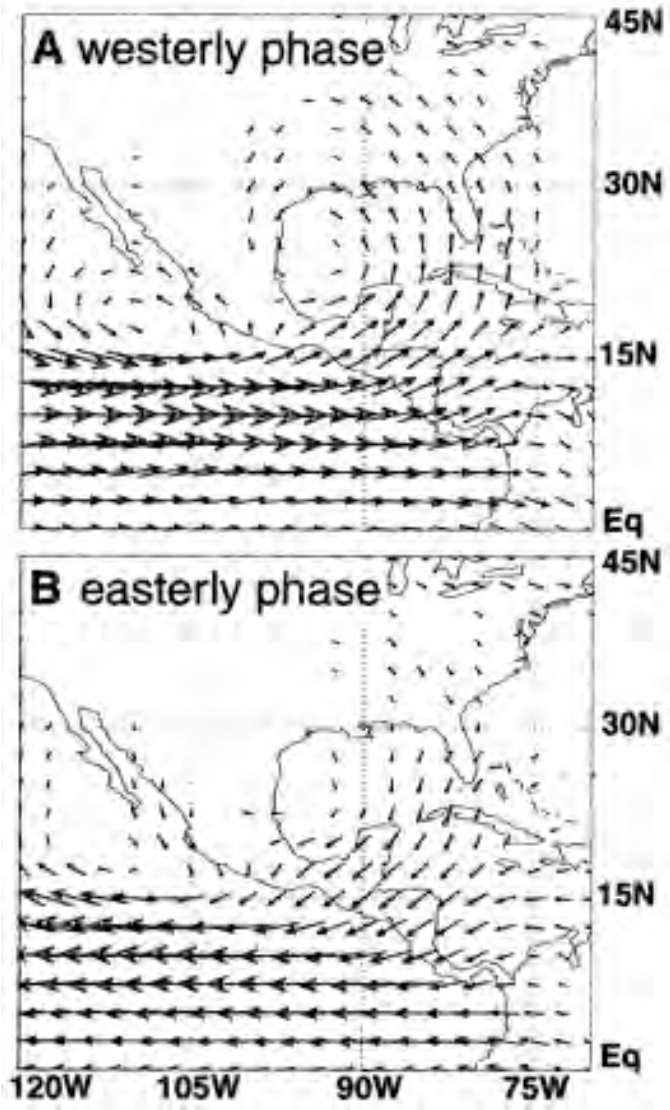
Madden-Julian Oscillation (MJO)

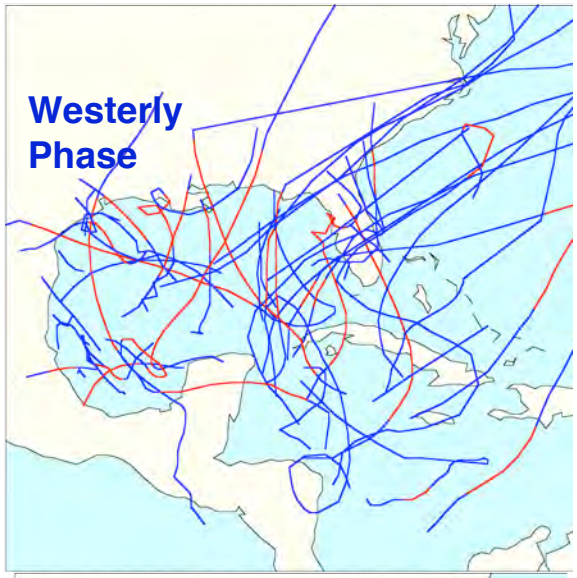
- Mode of tropical atmosphere-ocean variability that is characterized by coupled tropical precipitation and wind variations on 30-60 day timescales
- Associated with alternating low-level westerly and easterly wind regimes across the Tropics

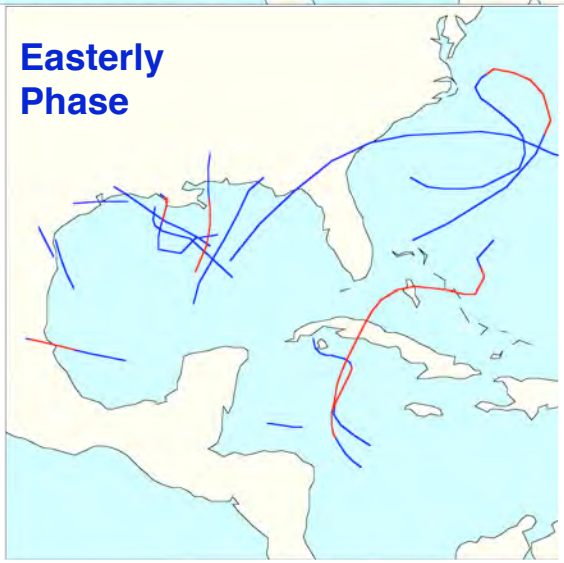


Madden and Julian (1972)

These Alternating MJO Wind Regimes are Associated with a Modulation of Tropical Cyclones Across the Tropics





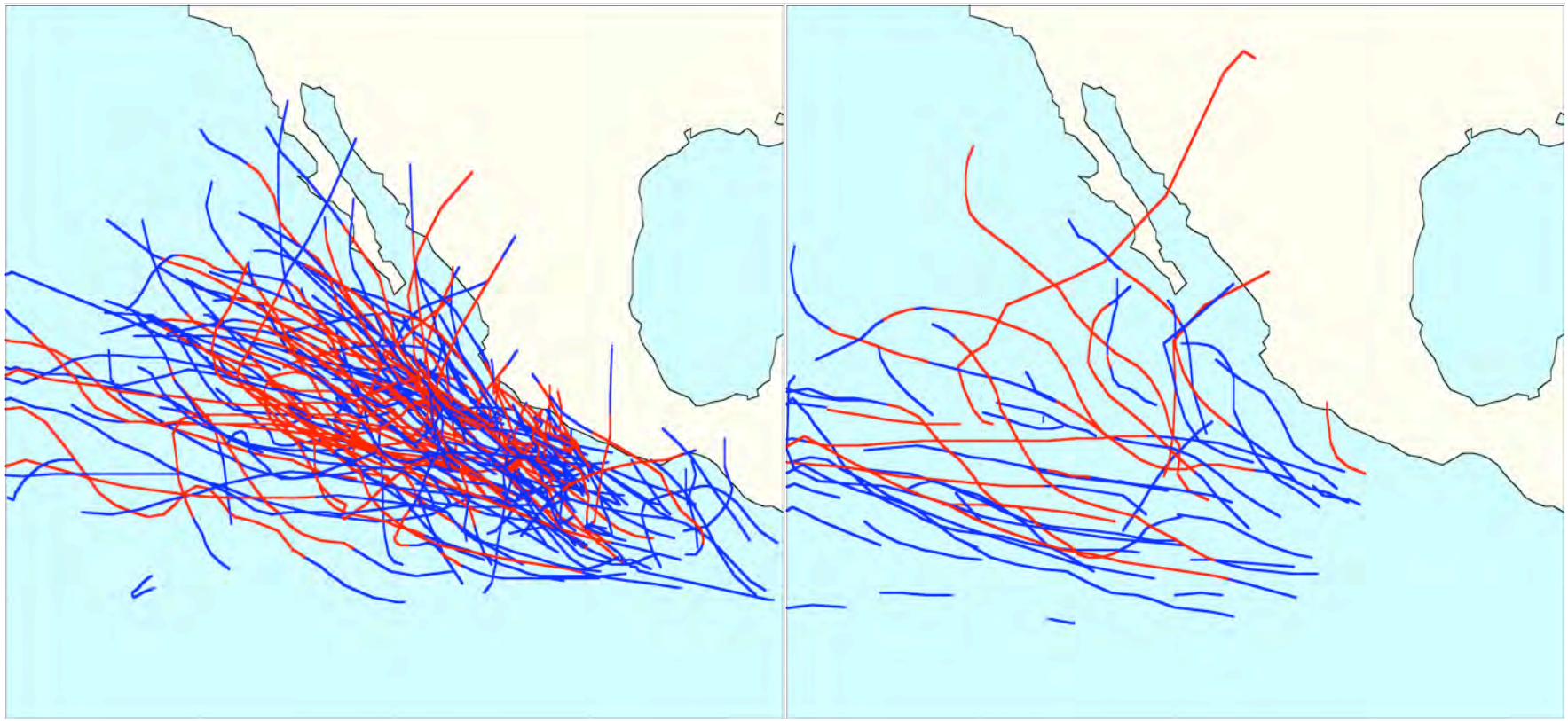


From Maloney and Hartmann (2000)

A Similar Tropical Cyclone and Synoptic Scale Wave Modulation by the MJO Occurs on a Tropic-Wide Basis

Enhanced MJO Phase
Low-Level West Winds

Suppressed MJO Phase
Low-Level East Winds



Blue=Tropical Storm Strength (>39 mph)
Red=Hurricane strength (>74 mph)

Figure courtesy E. Maloney, OSU

Wind Speed and Direction from Satellite

QuikSCAT, November 2002 – February 2003

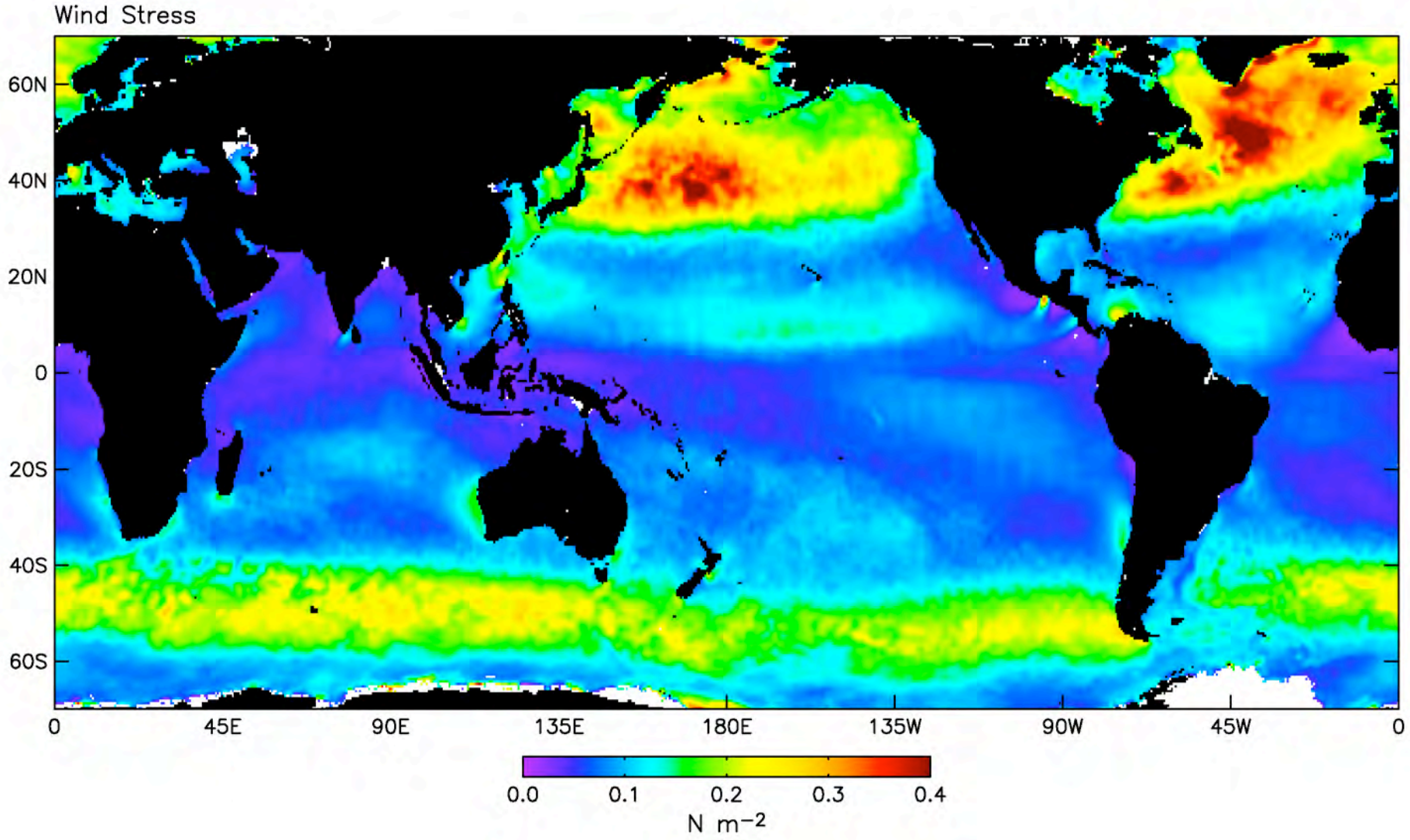
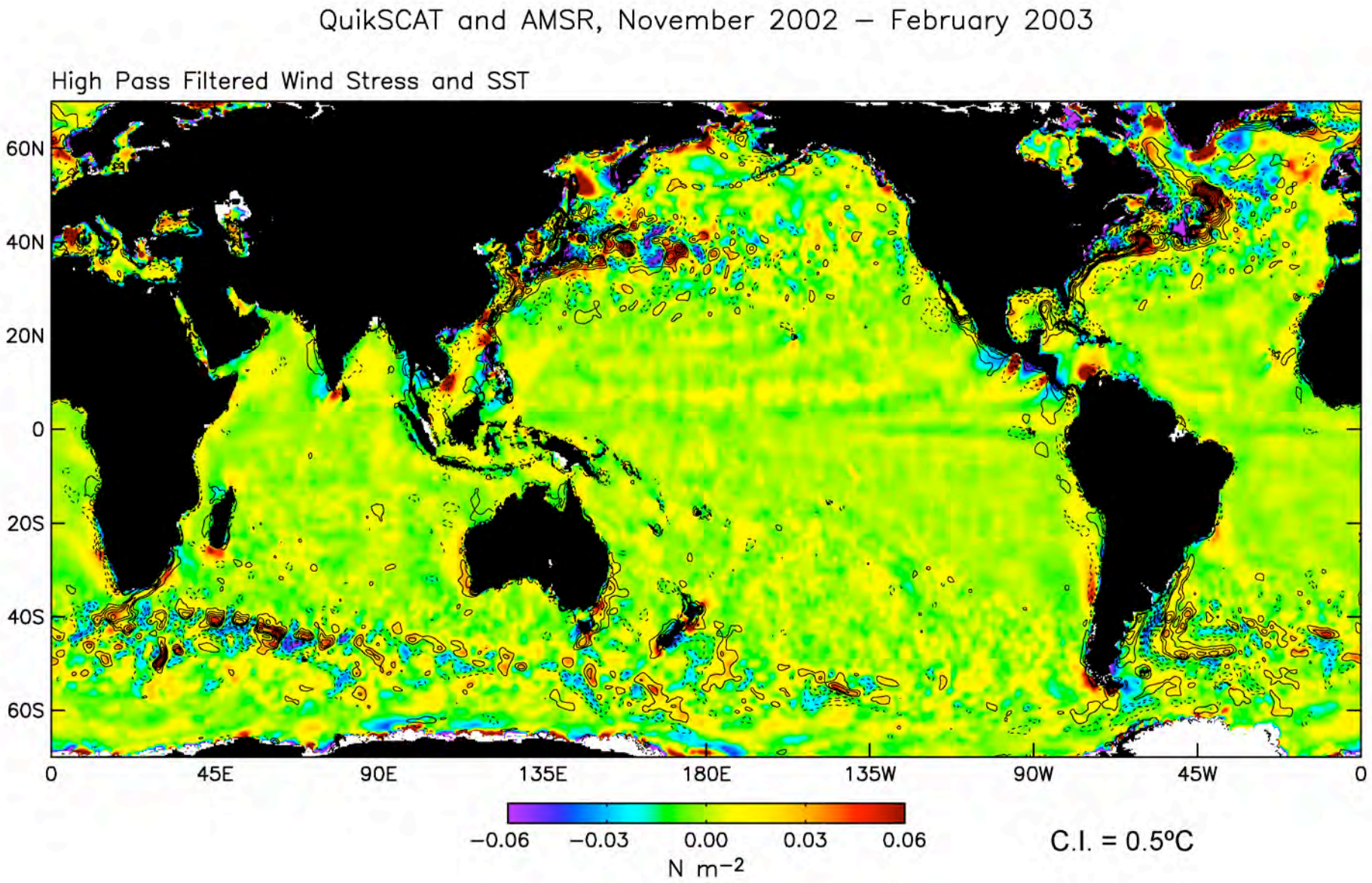


Figure courtesy D. Chelton, OSU



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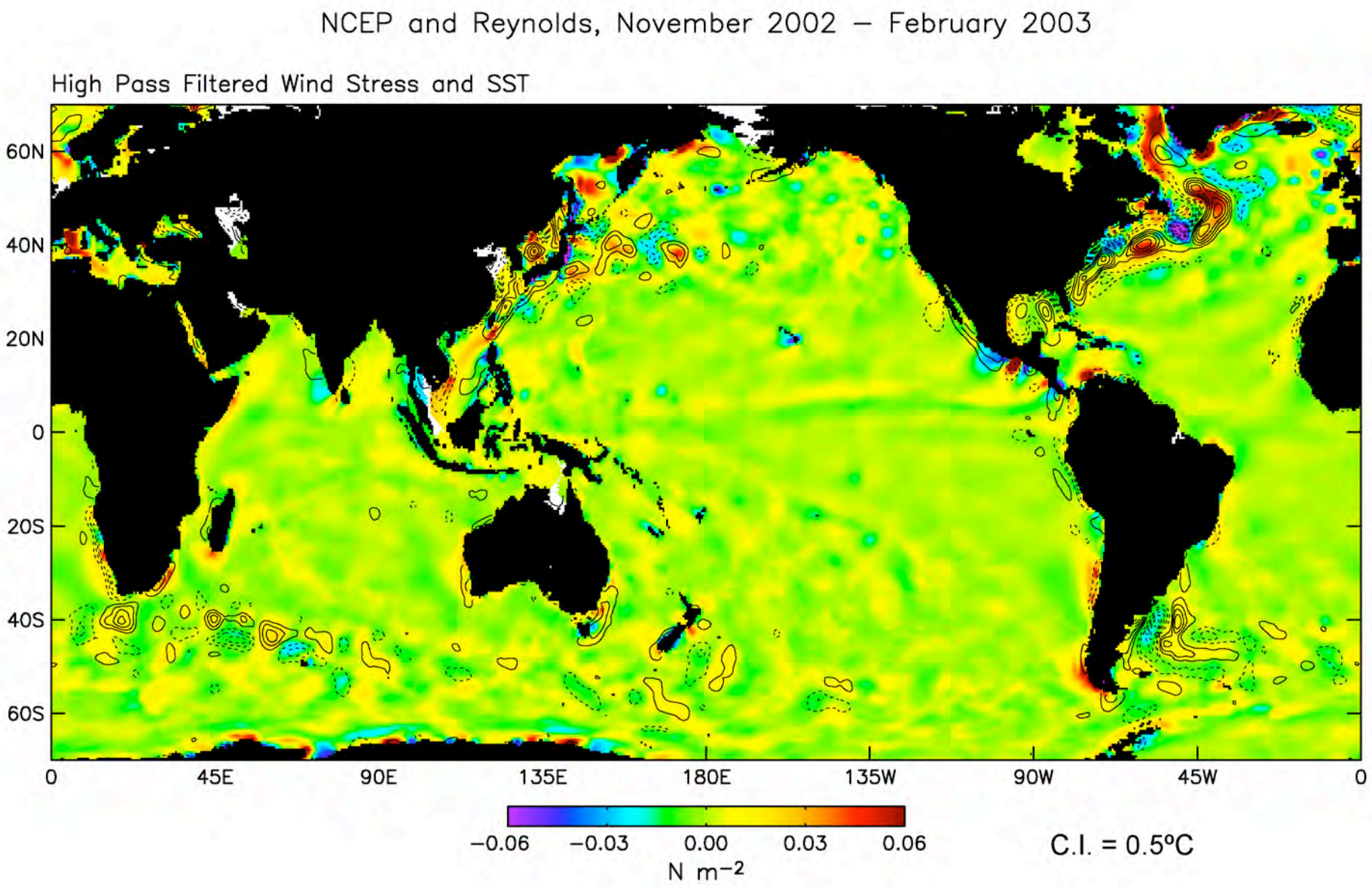
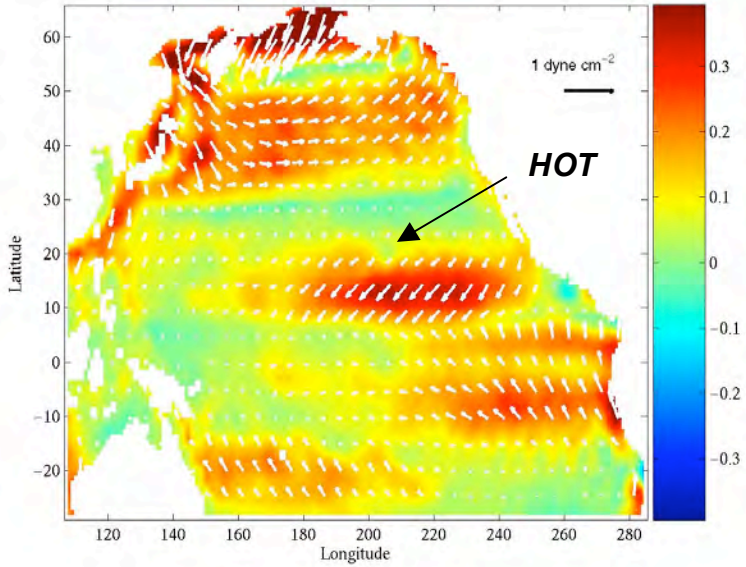


Figure courtesy D. Chelton, OSU

North Pacific Basin – Coupled Circulation/Ecosystem Modeling

- Examples of impact of errors in model forcing
- Differences between NCAR and Los Alamos models

Wind Stress



Sunlight

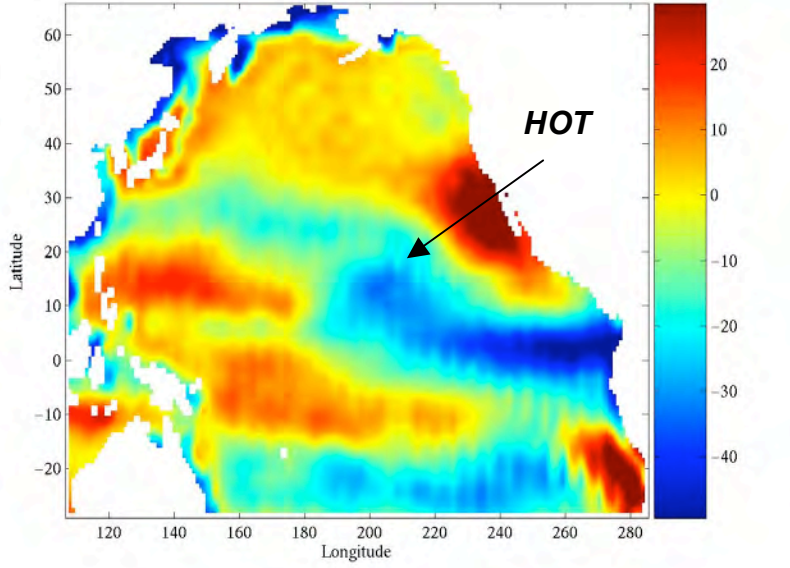
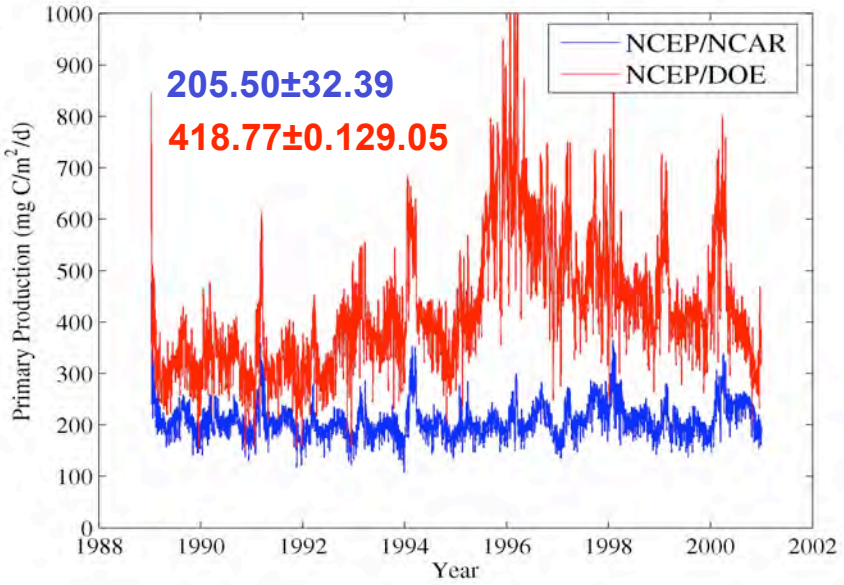


Figure courtesy Y. Spitz, OSU

Impacts on Ecosystem Models

Primary Productivity (0-150m)



Nitrogen Flux at 150m

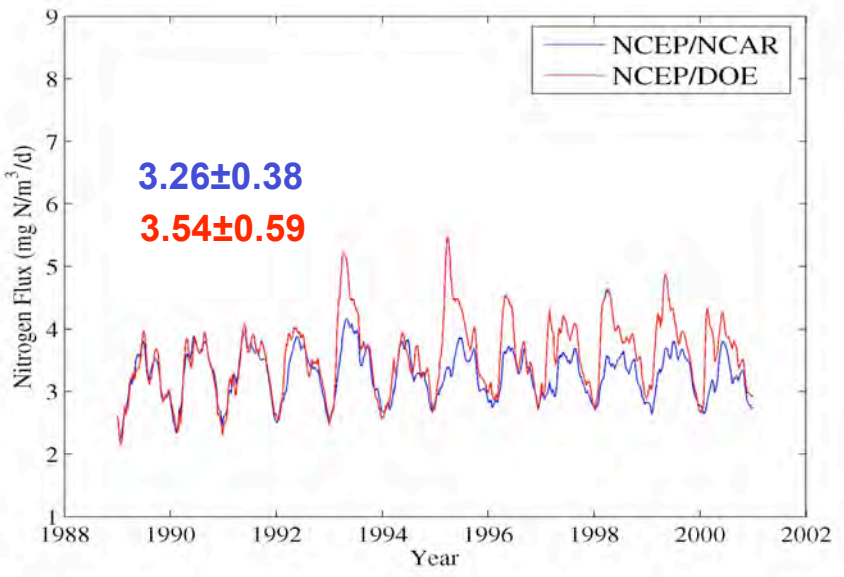
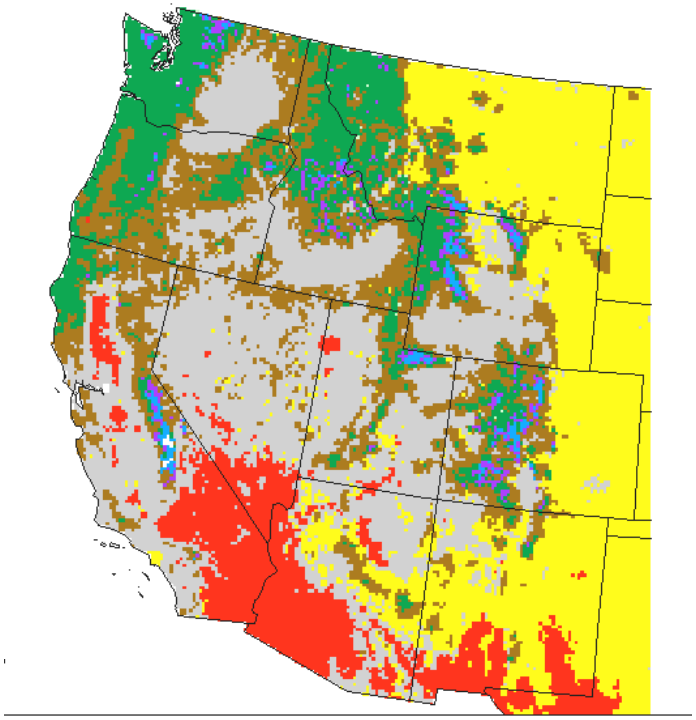


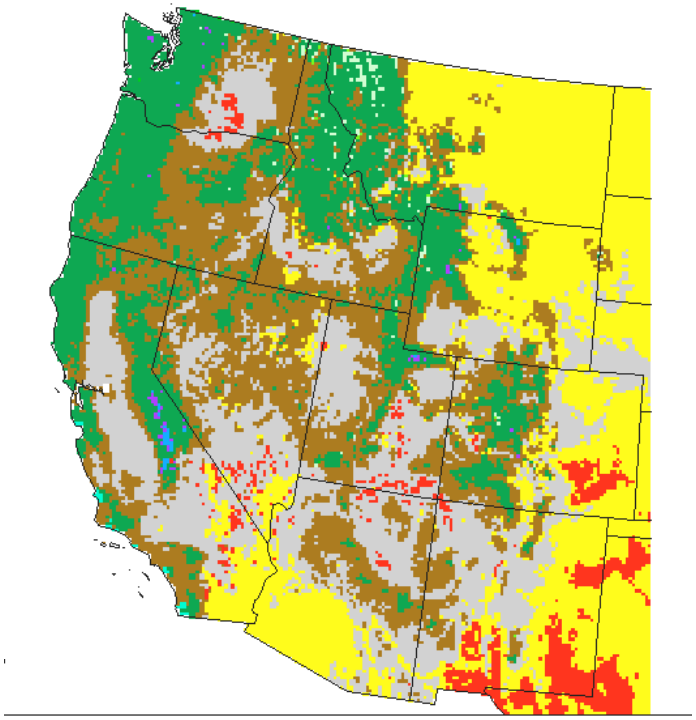
Figure courtesy Y. Spitz, OSU

MAPSS Simulated Vegetation Distribution

Current Climate



Future Climate



Woody and Grass Expansion in the West
Enhanced Carbon Storage, and
Catastrophic Wildfire

Figure courtesy R. Neilson, USFS/OSU

Changes in Tree Distributions with a doubling of CO_2

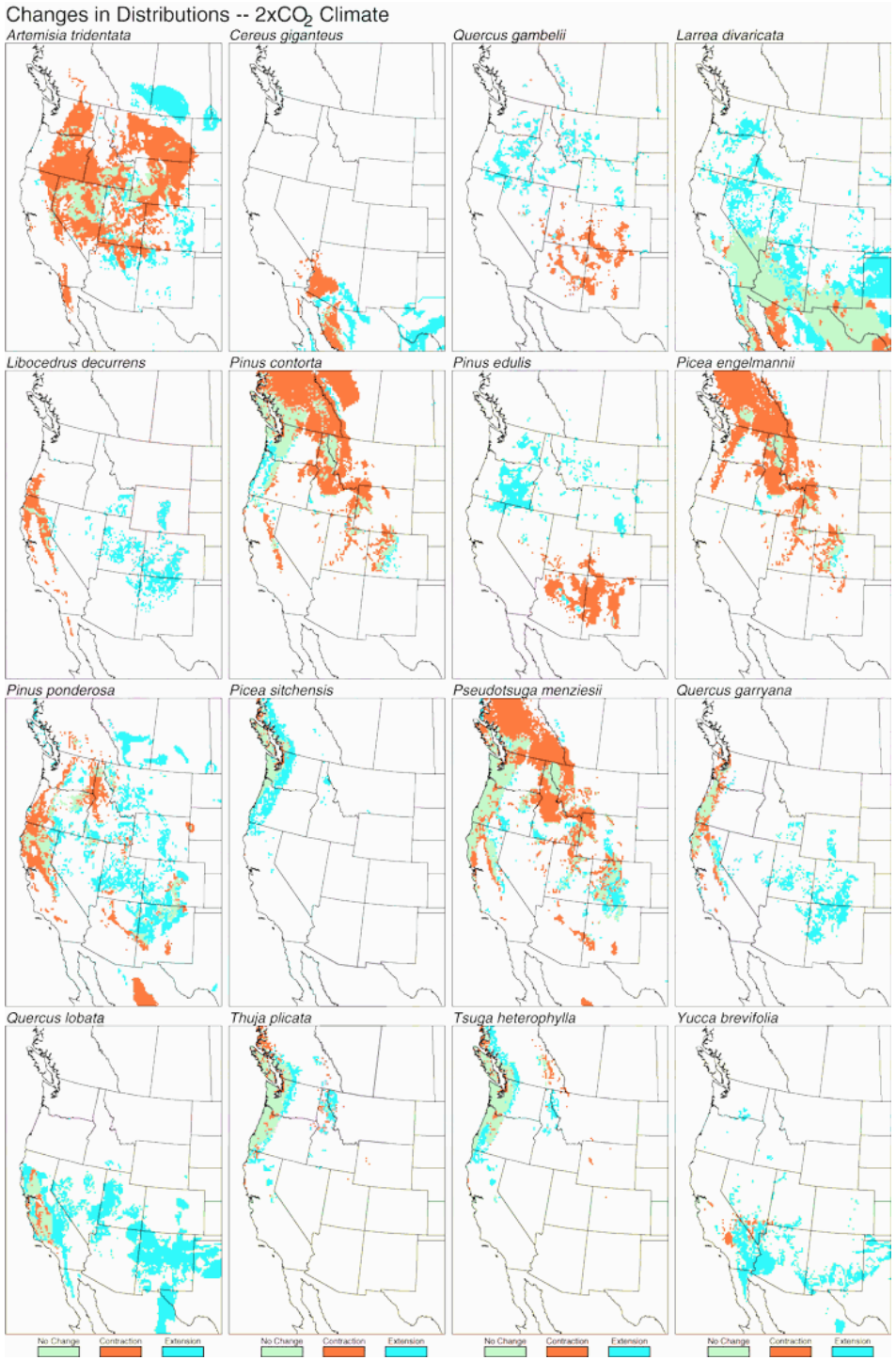


Figure courtesy R.S. Thompson et al., U. Oregon

Impacts of Spatial Resolution on the Types of Terrain that are Included in Models

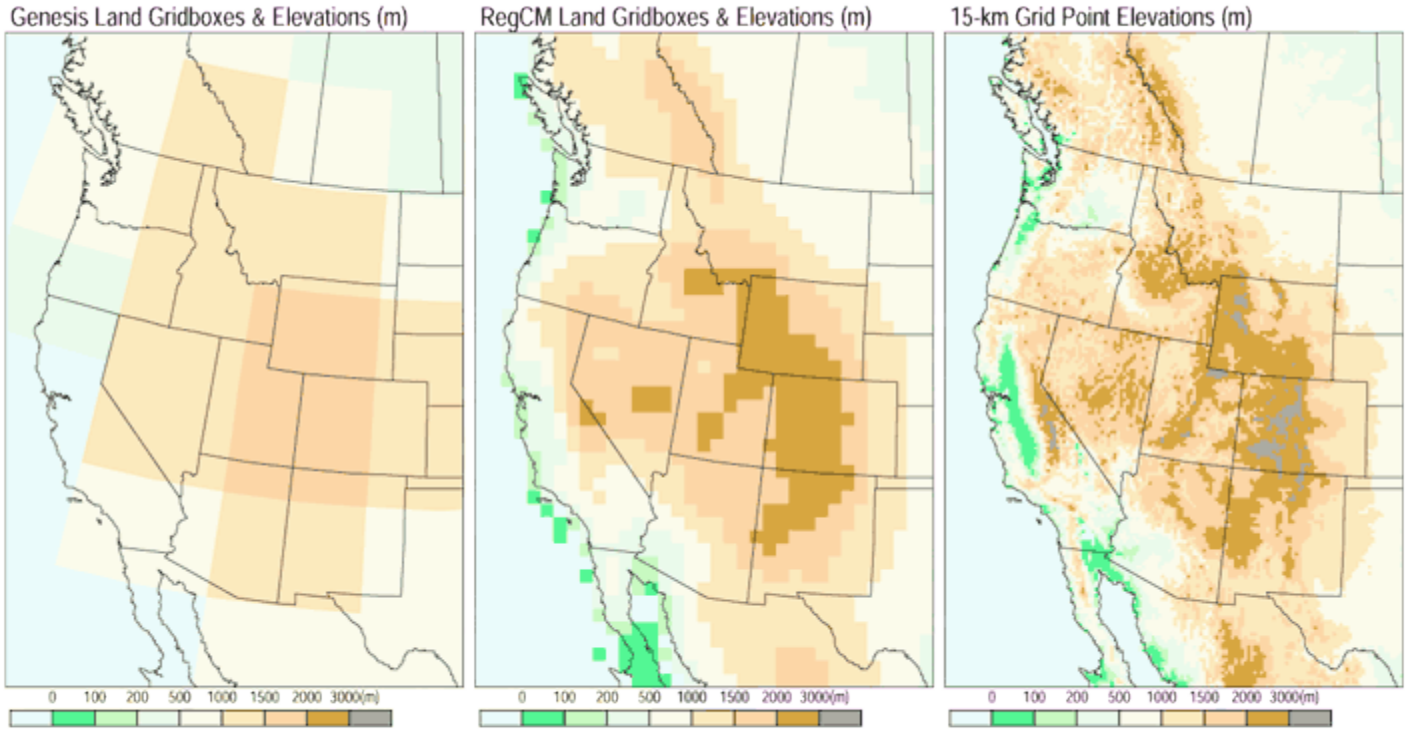
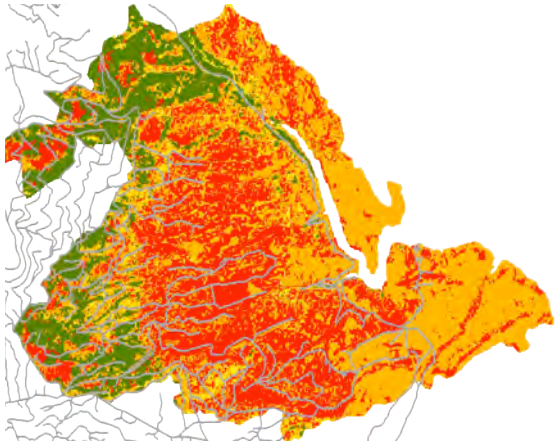


Figure courtesy S. Hostetler, USGS/OSU

Effects of Disturbance from Wildfires: Emissions, Changes in Carbon Stocks and Net Carbon Uptake for Years After Fire

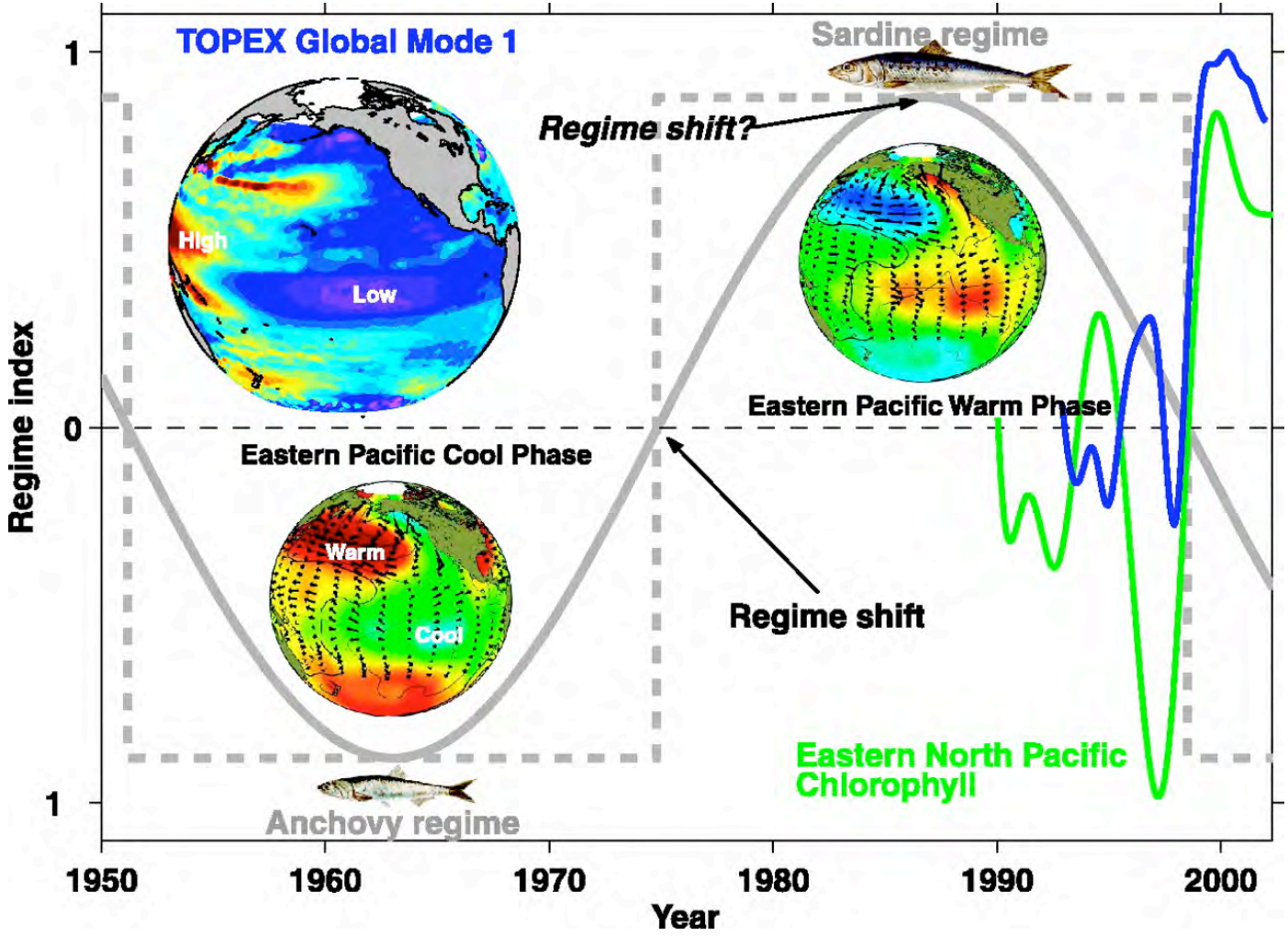
Satellite fire perimeter mapping

Figure courtesy B. Law, OSU

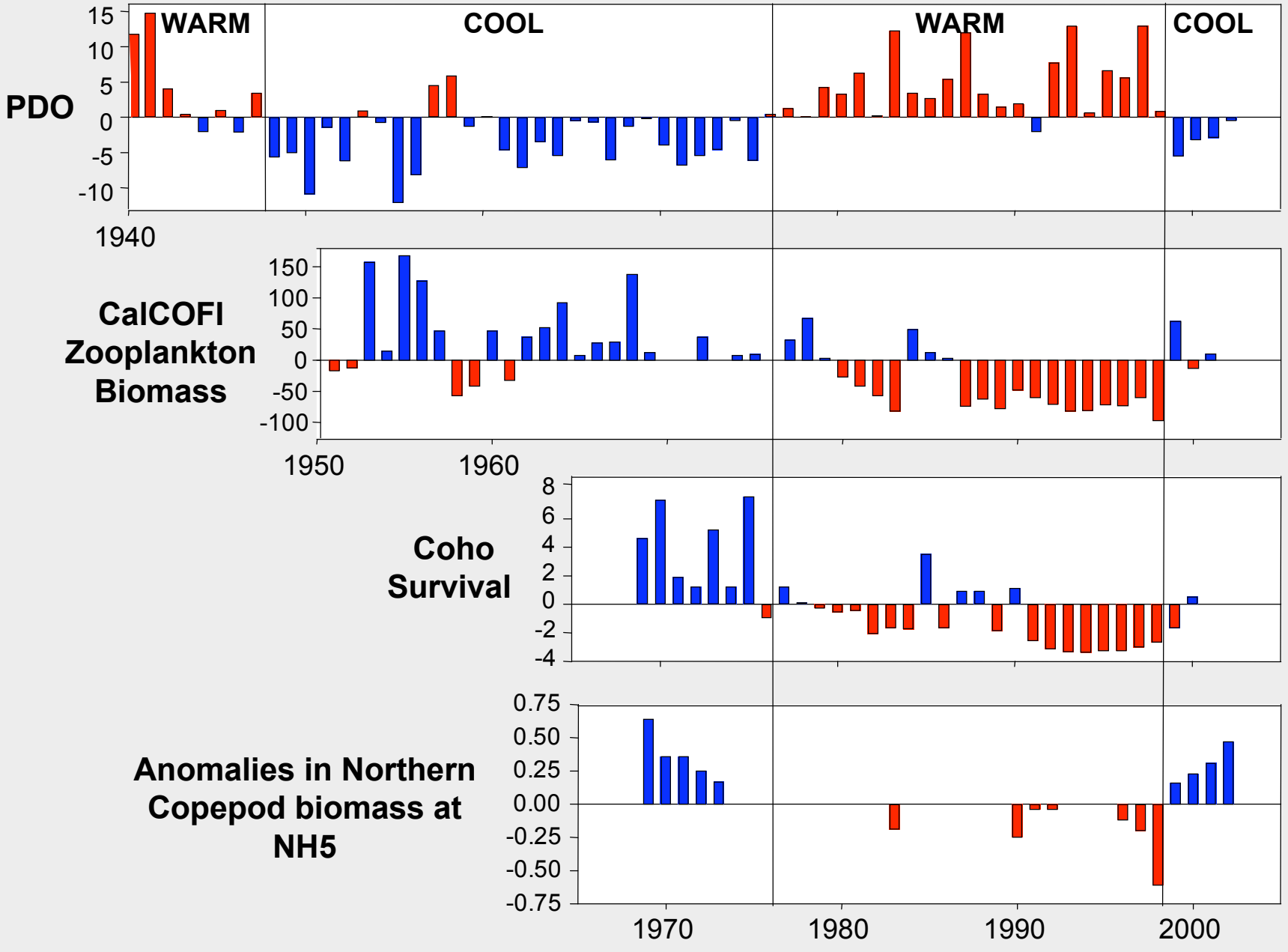


Fire severity mapping

Global Processes



(Chavez et al., 2003)



(from Peterson & Schwing, 2003)

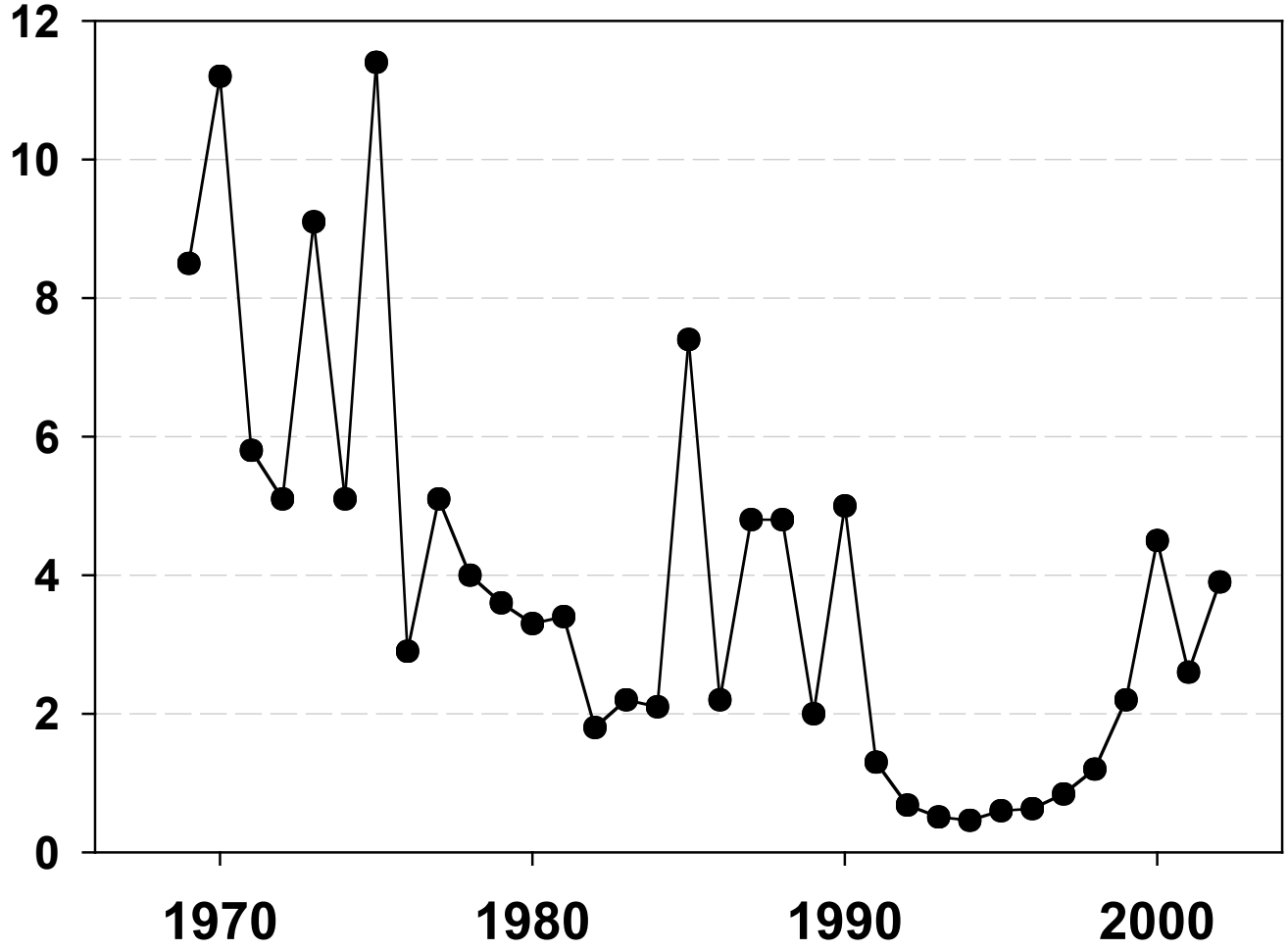


Figure courtesy W. Peterson, NOAA/OSU

OPI Marine Survival vs. Cold-Water Copepod Index

(black = '69-'73, '83, '91-'02; red= '83, '91-'02)

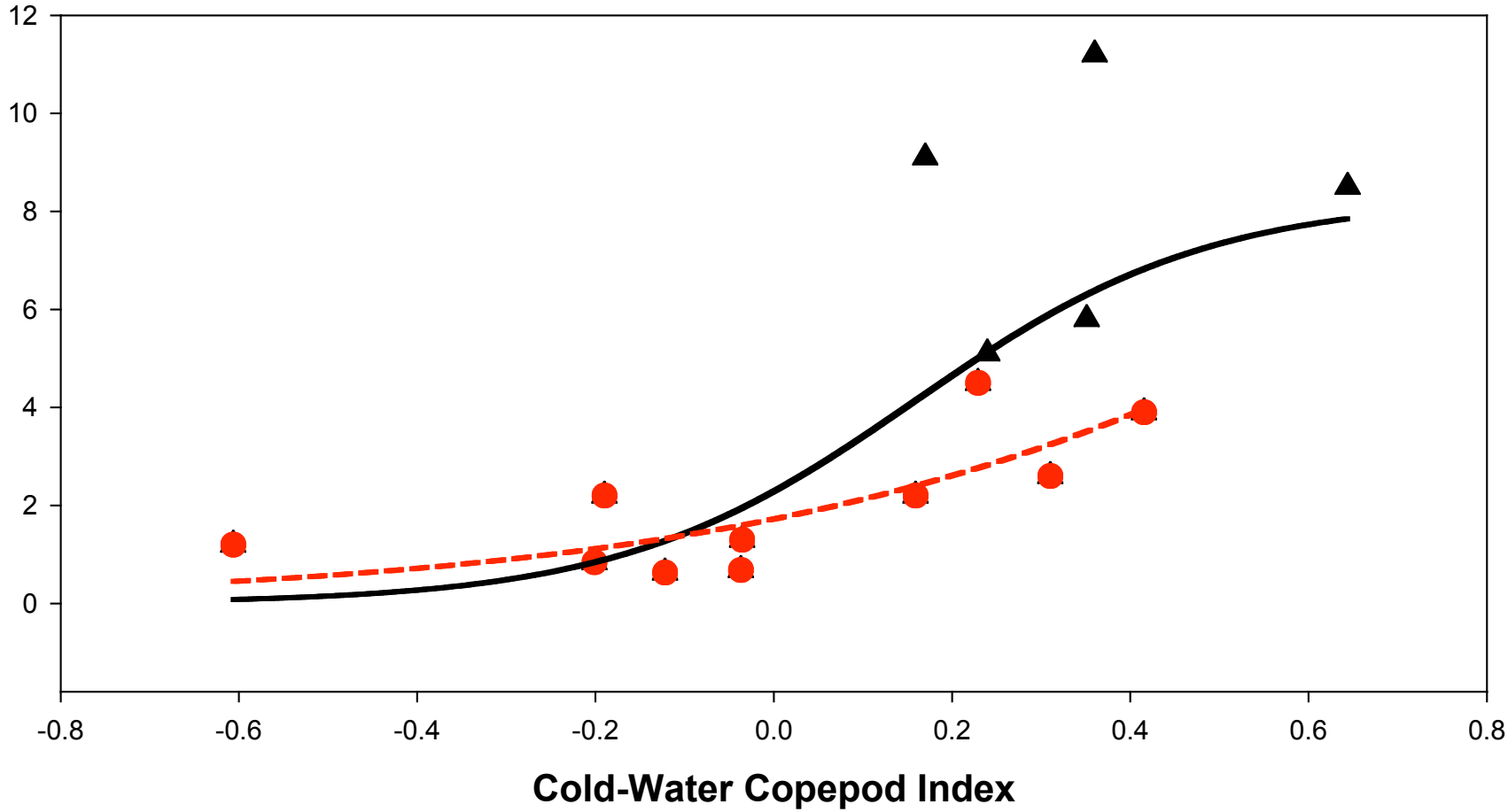


Figure courtesy W. Peterson, NOAA/OSU

The 1999 Transition

- Changes in the SST patterns in the 1990's may be a new pattern, not just a reversion back the "warm" regime that began in 1977
- Salmon survival has increased in the PNW but has not decreased in the Gulf of Alaska
- Bond et al. (2003) suggest new regime with strengthening of both Aleutian Low and N. Pacific High
  - Warm SST anomalies in Gulf and cold SST anomalies in the Calif. Current

Rockfish – 2001 vs. 2002

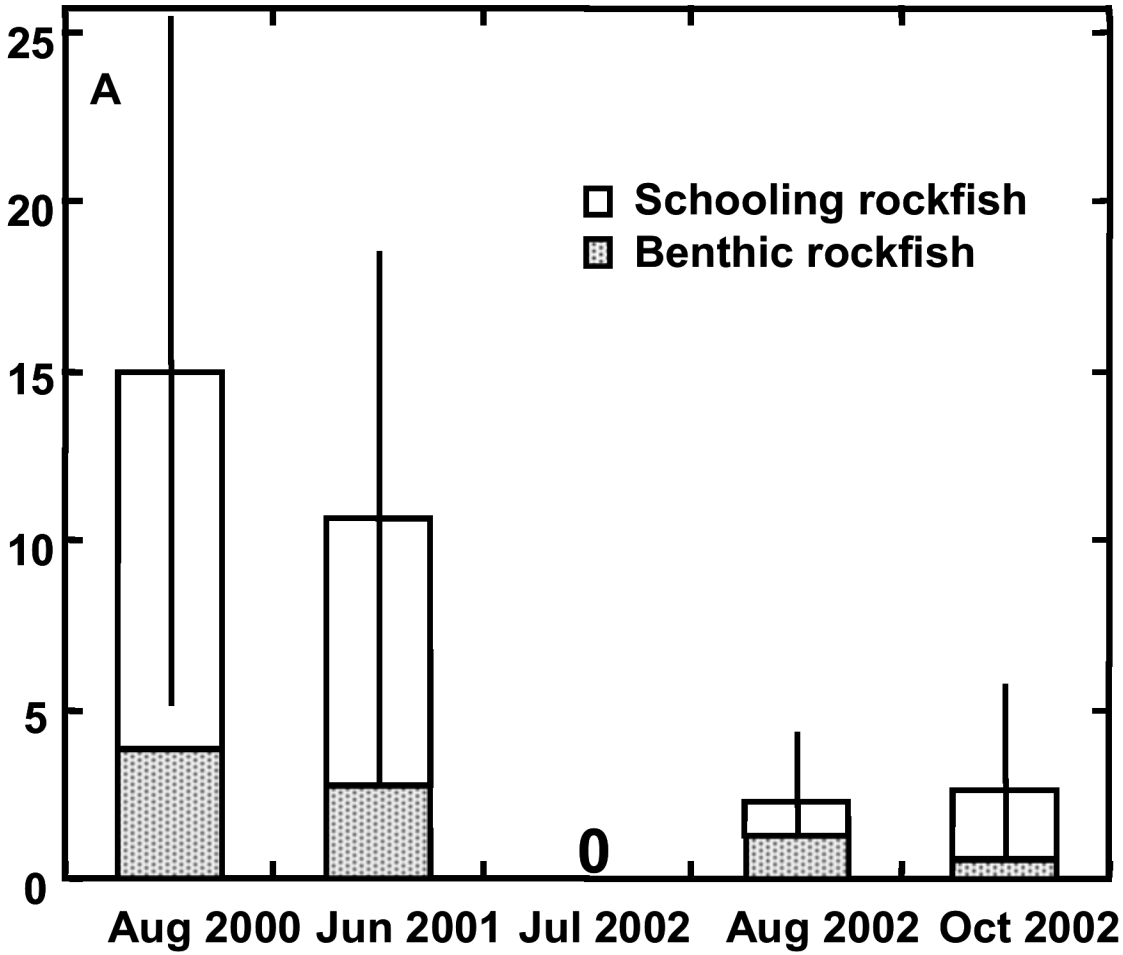


Figure courtesy D. Fox, ODFW

Climatology of Chlorophyll and Harmful Algal Bloom "Hot Spots"

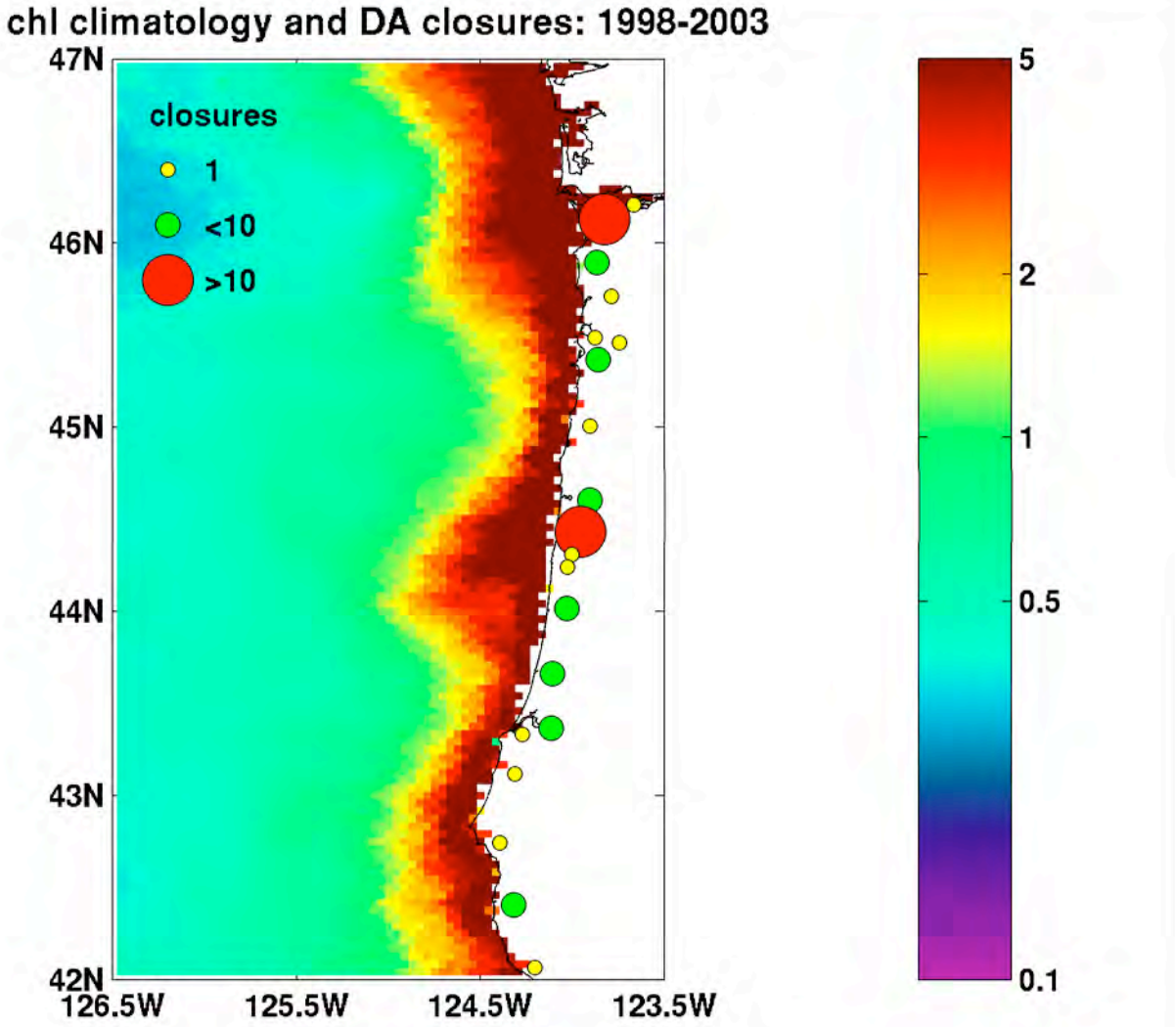


Figure courtesy P. Strutton, OSU, and M. Wood, U. Oregon

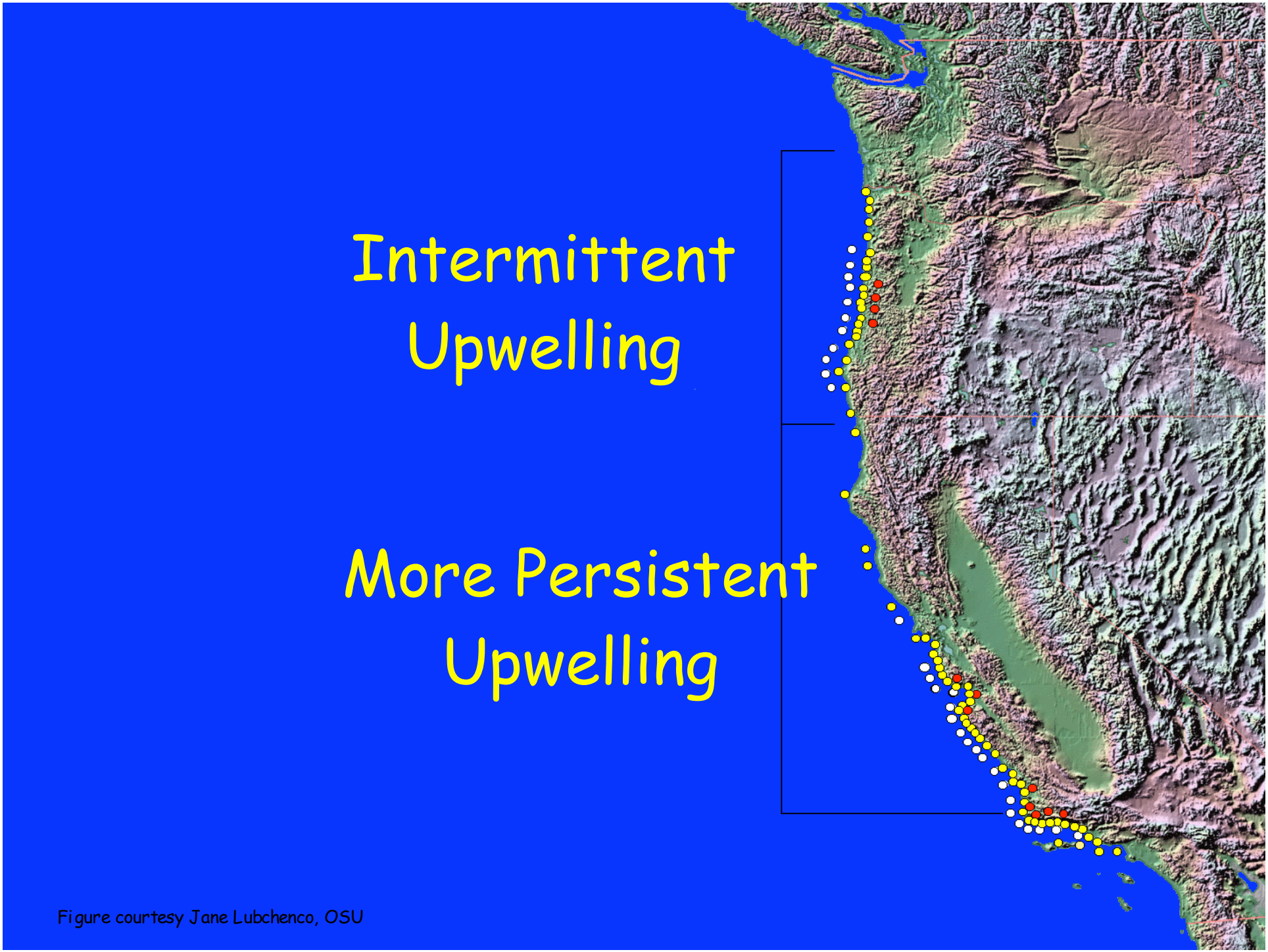


Figure courtesy Jane Lubchenco, OSU

Recruitment varies considerably along the coast

Acorn Barnacle

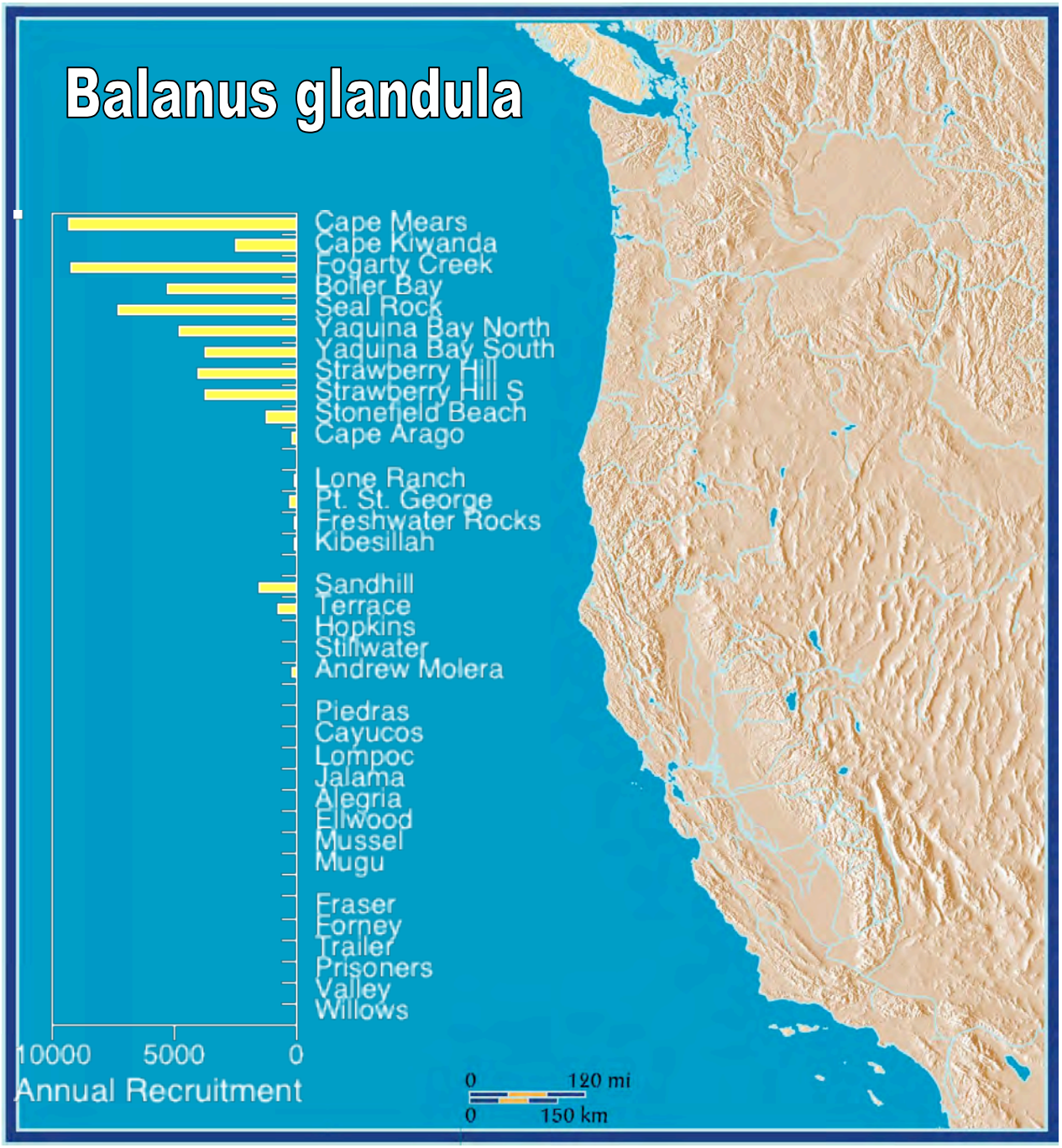


Figure courtesy Jane Lubchenco, OSU

Some Ecological Ideas

(from O'Neill, 2001; De Leo and Levin 1997; Tompkins and Adger 2003)

- Need to understand structure and function
  - Models generally follow one (structure and species) path or the other (functions and cycles)
  - But these two are clearly linked
- Ecosystem concept relies on underlying assumptions of homogeneity and stability
  - But heterogeneity and disturbance – and their associated spatiotemporal scales – are critical
  - "Ecosystems" are seldom close to equilibrium
  - Heterogeneity depends on "perception" by organisms which in turn depends on life stages, dispersal abilities, etc.

Ecosystem Integrity

- Integrity refers to preservation of components and relationships
- Resilience refers to maintenance of patterns and processes in face of variability
- Stability is a scale-dependent concept
  - Local/short-term recovery
  - Flexibility to maintain variability as conditions change
  - If we focus solely on ecosystem function, we tend to view ecosystems as dominated by physics and chemistry
    - This works on short time scales
    - On these short time scales, changes in structure are unlikely to occur

Climate Change and Public Policy

- Regard people as a "keystone species," not just extracting ecosystem services
  - Change patterns and scales of disturbances
- Require combination of social and ecological systems
  - Respond to new information and understanding
- Combination of adaptation and mitigation
  - Integrated and inclusive approaches to policy formulation and refinement

The Landfall of Hurricane Frances

(an example of the daily progression of hydrologic conditions)

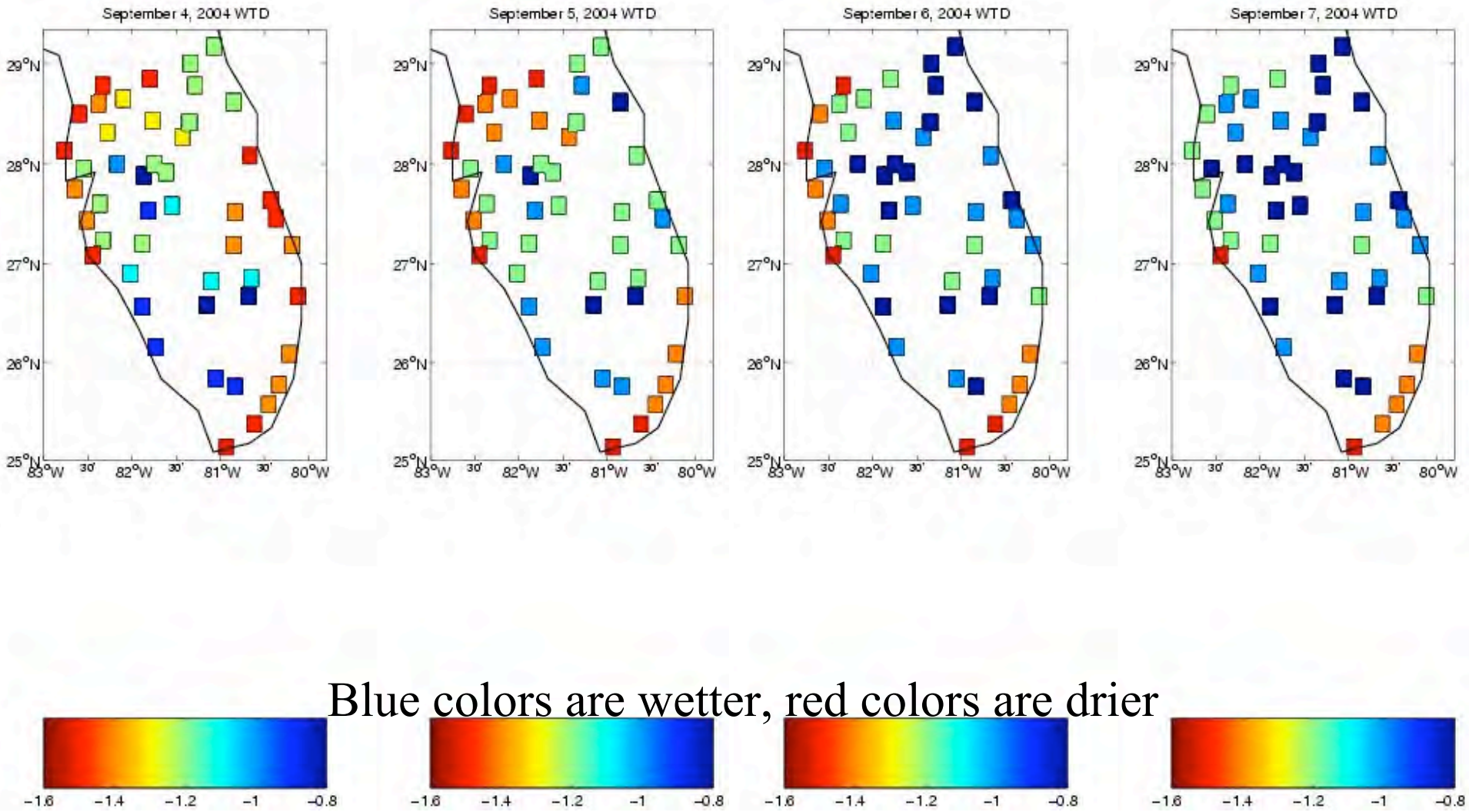


Figure courtesy J. Shaman, OSU